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Abstract
This report summarises the results of a study that was carried out by SCF Associates Ltd for the European Commission, Institute for Prospective and Technological Studies, Joint Research Centre, Seville, Spain.
Key enabling technologies (KETs) could be a crucial part of the EU's response to the economic crisis over the past decade. More jobs and growth are expected from investments in KETs, hoping they may lead to a more prosperous society through higher skills and wages, while expanding innovative high technology exports globally.
Consequently, KETs, especially the five ICT KETs examined in the following chapters, should be seen as having a strategic social importance. The initiative will catalyse not only product innovation but also the industrial process. Moving from innovation to commercialisation in a three-pillar model (RDI, pilot lines, and then full commercialisation) is its fundamental advantage over previous innovation programmes. It may assure the success of the EU's future global competitive position, as it can stimulate high levels of skilled employment. That should address many of the grand challenges facing European society and its economy.

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Acknowledgments

This report summarises the results of a study that was carried out in 2013-2014 by Simon Forge and Colin Blackman of SCF Associates Ltd for the European Commission, Institute for Prospective and Technological Studies, Joint Research Centre, Seville, Spain.

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Executive Summary

Key enabling technologies (KETs) could be a crucial part of the EU's response to the economic crisis over the past decade. More jobs and growth are one of the European Commission's expectations for Europe's investments in KETs. It is hoped they may lead to a more prosperous society through higher skills and wages, and at the same time increase innovative high technology exports globally.

Consequently, KETs, and especially the five KETS in Information and Communication Technology (ICT KETs) examined in this report, should be seen as having a strategic social importance. The initiative can catalyse not only product innovation but also the industrial process. Moving from innovation to commercialisation in a three-pillar model (RDI, pilot lines, and then full commercialisation) is a major change over previous innovation programmes. Here, it is worth noting some vital points about ICT KETs for Europe's industrial resurgence:

- Europe has variable strengths across the five ICT-related KETs but does not lead the world in any, although its position in some, such as nanotechnology and advanced manufacturing, is strong.
- The aim of the KETs initiative – to support companies to cross the "valley of death" – may contribute to changing Europe's image as being mainly an inventor and consumer to also being a developer and manufacturer.
- However, the KETs initiative may also be seen as a top down approach, with arbitrary selection of technologies, priorities and definitions. They may not coincide with the targets of industry players, markets, or Member States.
- Also, there is a potential risk that support for commercialisation could contravene of state-aid rules, because companies which would have performed the R&D, and invested in pilot lines or full production anyway could receive funding. Care is needed to ensure that competitive markets are not compromised.
- Since there are questions over the scope of KETs in view of state aid, an amended industrial policy for Europe may be necessary. Careful strategic analysis is first required.
- The major players in the KETs initiative today are the larger industrial groups, with their industry bodies. KETs initiatives can also focus on micro-firms and SMEs, with substantial funding. They are the backbone of the European economy and the lifeblood of Europe in terms of innovation, employment and new growth. Large firms naturally tend to concentrate more on internal efficiencies via higher employee productivity and also on market position.
- Pillar 1 (RDI) is the first point at which the scope of the KETs initiative can be revised and wider views possibly taken on subject areas for ICT KETs.
- However, KETs is a technology-oriented programme. For Pillar 2 (pilot lines) and 3 (commercialisation), widening the scope of the KETs initiative to high-risk commercial exploitation means considering the combination of technology and design for product innovation in ICT KETs, not just at the R&D stage but at the pilot prototyping stage, ready for commercial production. But support for commercialisation in pillar 3 means far more of the commercial aspects must be incorporated, especially for ICT KETs to have strong market impacts.
- ICT KETs may form the basis, at regional level, of industrial regeneration by a transfer of skills that can be embedded locally, having assessed the structural conditions necessary for innovation in a specific KET. The basic mechanism is to build high-technology clusters, using smart specialisation techniques to map KETs, regions and cluster components.

The report ends with further proposed actions to promote success with ICT KETs. These include better understanding the socio-economic impacts of KETS.

1. Introduction

This report assesses the current state of the EU's key enabling technologies (KETs) initiative, draws lessons and recommendations for possible policy actions in the EU with regard to five KETS in Information and Communication Technology (ICT KETs)[1] and considers ICT KETs R&D, innovation and market impacts. It also explores the potential need for additional research to contribute to a better understanding of the importance of KETs to the EU's future innovation landscape and the consequent impact on the EU's economy and society.[2]

1.1 The importance of KETs for Europe in terms of growth and jobs

The KETs initiative signals a distinct policy shift towards support measures for commercialisation of R&D. KETs are considered to be of strategic importance because they underpin not only technologically-based product innovation but also process innovation potentially opening up new opportunities for highly customised technological services with global demand. Their impact could be felt across the EU economy, and could be significant in developing affordable new products and services for European consumers, for instance in renewable energy, health or transport.

Recent decades have seen a shift of substantial parts of the manufacturing value chain to countries outside the EU, in particular to Japan, Korea, China and the USA, as well as the BRICs. Outsourcing has also gradually changed with less focus on cheap labour and access to emerging markets and more emphasis on access to availability of high-value manufacturing and R&D based on local graduates and skills. KETs are seen as fundamental to reversing these trends with consequent impact on skills and jobs.

1.2 SWOT Analysis

Strengths and weaknesses

The EU has traditional strengths in R&D generally, and has specific and relevant capabilities in many areas of KETs research. In terms of patents and trade performance, while the EU does not lead the way in any of the KETs, some Member States (e.g. France, Germany and the Netherlands) perform well in all five ICT KETs compared with China, Japan, Korea and the USA. The EU compares well globally in nanotechnology, but in semiconductor technologies US and Asian companies dominate global production. The photonics domain is also well represented in the EU, with much R&D and intellectual capital, but mass production of photovoltaics has become an Asian-dominated industry. It is a similar picture in fabrication of new ICT displays for smartphones and tablets, based on OLEDs and electronic ink, despite the fact that much of the original intellectual capital originated in Europe.

The main strength of the KETs initiative is the new focus on support measures for commercialisation of R&D, which addresses the lack of public support for EU companies in the early stages of commercialisation, especially for SMEs, in comparison with Asia and the USA.

1 Micro and nano-electronics, nanotechnology, photonics, advanced materials, and advanced manufacturing systems.

2 This report draws on research by SCF Associates Ltd for IPTS, mainly based on secondary research, supported by limited consultation with stakeholders. This report is therefore underpinned by: a database of existing literature related to KETs in the EU and relevant non-EU countries, with regard to policy, and R&D, innovation and markets; and a descriptive analytical report summarising the findings of the available literature.

Opportunities and threats

The EU KETs initiative could level the playing field with other regions and nations who already provide such support for their domestic high-technology players. This shift puts the EU on a more equal footing with countries such as China, Korea, Japan and the USA. The first step beyond R&D – pilot lines – offers a valuable mechanism especially for SMEs to carry out essential testing using expensive equipment at low cost. In particular this creates the opportunity for SMEs to cross the "valley of death".

Support measures for commercialisation, however, could result in market distortion if they simply involve offering subsidies. There is also no value added if support is given to companies which would have carried out their activities anyway. Furthermore, there is a risk that such funding might contravene the EU's state-aid rules.[3]

2. Lessons and Recommendations for EU policy actions

2.1 The three pillars approach

The EU KETs initiative is aimed at advanced technology ventures that are high risk owing to their capital intensity, long development times and complex production processes. For start-ups and especially for micro-enterprises and SMEs of this kind, there is little risk capital available. This is the context in which new thinking behind the KETs initiative on support of innovation through to commercial exploitation has been applied, addressing three pillars, from R&D to full commercial operation, via prototyping and pilot line manufacturing. What follows is guided by this approach, with various relevant issues being raised:

- How can support of this kind avoid distorting competition? If support measures for commercialisation of KETs appear to distort competition and infringe the EU state aid rules, could this lead to an amendment of the current legislation to allow a form of EU-level aid? However, any amended legislation would still need to conform to WTO principles.
- How can SMEs be supported?: The KETs programme has, up until now, mainly been identified with the larger firms in each sector and their industry associations. More support could be also given to those companies which tend to drive three key economic areas – new employment, introduction of new skills with that employment, and innovation. Many of these are micro-enterprises and SMEs. These companies are very important for regional development as they provide around 45% of the value added by manufacturing for around 59% of manufacturing employment (Eurostat, 2010).

Hence, an "integrated industrial policy approach" that permits post-R&D support in pillars 2 and 3, with a more interdisciplinary KET support could be effective. The amendment of state-aid for EU-level interventions could be considered. Moreover, more support for micro-enterprises and SMEs, which are at the heart of innovation and employment, could also be included.

2.2 Pillar 1: R&D in ICT KETs

Lessons from Pillar 1

The R&D support for Pillar 1 is largely in line with the EU framework programmes of the past. The key finding of this study is that the definition of KETs in terms of its current subject areas means that a programme destined to run until 2020 could miss opportunities by targeting a narrow industry range. Other KETs areas could be the subject of support for R&D from Pillar 1, as well as from the subsequent two pillars.

[3] Multi-KETs Pilot Lines Consortium (2013), Vision and characteristics of multi-KETs pilot production activities Draft V5.0, 2013, http://www.mkpl.eu/uploads/media/mKPL-_Green_Paper_v5.03.pdf.

Recommendations for Pillar 1

In consequence, a key recommendation, starting in Pillar 1, is to re-evaluate the classification of ICT KETs in terms of the current five subject areas and overlaps between them. The current list appears to be restricted by specific interests in the six areas, often with a view to particular final products that include photovoltaics and batteries, as these seem sensible today. Several future ICT areas could also be included as ICT KETs for initial R&D and leading to full commercialisation, which include for instance:

- Radio technologies (e.g. small cell technology, sometime termed '5G' and the more novel industrial and mesh networks for on-interference techniques in licence-exempt bands) which have expected R&D demands of €3 billion in R&D (with €700 million promised already from the Commission for the 5GPPP initiative (Merritt, 2013, European Commission, 2014) to meet increasing demands in mobile data according to forecasts by Cisco's Visual Networking Index (Cisco, 2014). This has two sides – the engineering of radio propagation with spectrum use and the signal processing required. It may go further and embrace novel developments in the field of machine-to-machine (M2M) radio communications – sometimes termed the Internet of Things (IoT).
- Advanced mechanical engineering, which depends on simulation for the complex integration of electromechanical systems. This covers a range from MEMS at a nano/micro-level, up to automotive, consumer appliances and into aerospace, marine systems, civil construction, etc. and thus mechanical engineering innovation and design.
- Robotics as a separate subject, not just for advanced manufacturing but for SME use in co-worker situations for very simple activities (carrying, holding, etc) perhaps and possibly in future health care as well as long term care of older people and the infirm (IPTS, 2010).
- Software in general is perhaps the largest gap, as software technology will form the basis of the future European economy – including, for instance, the items above. Radio technologies of the future will rely on software-defined radio (SDR) front ends, which may also use MEMs for the MIMO antennae that will connect future networks. Thus, much innovation will increasingly tend to be embedded in software (ISTAG, 2013).
- Inclusion of organic semiconductors and biotechnology specifically for ICTs – in new semiconductor substrates and devices, sensors, displays and power sources, as well as in software principles and structures for relational processing, operating systems and cyber security.

2.3 Pillar 2: Innovation impacts of ICT KETs: leadership in enabling and industrial technologies

Lessons from Pillar 2

It is still too early to assess the progress of KETS progress in Pillar 2. However, there are some European ICT successes and also failures that may be analysed for their lessons for ICT KETS and their innovation impacts. Perhaps the most compelling are in mobile communications specifically. First is perhaps one of the leading innovators in mobile computing:

- The microprocessor designs for low power from ARM (Advanced RISC Machines) founded in Europe, accelerated take-off of the European mobile handset industry (by Nokia, Ericsson and the mobile network operators), reflecting the needs of the mobile industry for low power consumption. Today ARM processors power over 90% of mobile devices globally. The lesson is that observing market trends in the target segment is vital during the formative growth stages and products and services should be shaped accordingly. There is some awakening to this issue in later KETs thinking (de Helde et al, 2013) but it needs to be fully formulated. ARM also benefited from an innovative business model –i.e. sales of the designs only. ARM spends nothing on fabrication plants, which is a high-risk capital-intensive venture, subject to industrial cycles.

- A further example is the loss of leadership in mobile handsets by Europe to market entrants from the USA and Korea (Apple and Samsung). This loss was initially because of Apple's superior innovation in a different dimension – design – an aspect that the KETs programme does not address explicitly. In ICT, today and in the future, design is becoming increasingly important – often, more specifically, for the user interface in ICT KETs.

Recommendations for Pillar 2

From the above lessons three main recommendations that could advance the KETs initiative stand out:

- Encourage deeper understanding of the market reality of the demand side. This could start in Pillar 1, defining R&D, but lead in Pillar 2 in which product innovation takes place. It should include requirements analysis and market studies. Focusing on technology push, or continuing with revenue streams that are unsustainable, are common European failures in commercialising ICT innovations that may be avoided by using this approach. On the surface, this recommendation suggests that market analysis at the level of consumer devices should form a part of KETs projects. If ICT KETs are to succeed, the question of understanding market demands must be set within each of the three pillars but especially in innovation for industrialisation – Pillar 2 – in the demonstration and pilot line phase.
- Place industrial design at the same level as R&D in the KETs initiative as it forms an increasingly important aspect of consumer demand. In consequence, industrial design should form part of ICT KETs efforts, throughout the three pillars. Successful industrial design exercises use a subtle combination of technology innovations to build appeal to end users. The ICT KET design dimension requires further study to understand where and how it can be exploited in final products and services. Preparing this early for commercialisation in the product cycle is necessary in the real world for two main reasons. The first is to plan for bringing a new product to market from its prototyping stage, and secondly to showcase either new production methods, or the capabilities of new materials, in order to highlight their exploitation in the finished article. The first step in introducing design could be an initial analytic study on how to apply industrial design coherently. This step would vary by ICT KET, with an assessment of the potential of design for each ICT KET. The second step might be to evangelise the approach, as the milieu that is typically more technocentric than product aware. Note that design may be considered as an extension of all three pillars. A possible alternative is to consider design as a new layer of innovation, supporting all three pillars, with high application to the ICT industries at applications levels, as they encompass web services, products for the consumer society, as well as health and industrial infrastructures.
- Moreover, using a generic or standard business case for an ICT KETs venture which copies that of the established competition may not be the route to success. The recommendation here is to be as creative with the business model as with the R&D and product innovation. Avoiding competition, in order to deliver and dominate a different form of added value, may be as fundamental to long-term survival as the innovation itself. This is especially important for success in the ICT industry.

2.4 Pillar 3: Market impacts of ICT KETs

The policy around KETS raises several issues – from wise disbursement of funds, to having a strategy that responds to demand-side market pull rather than supply-side push while assuaging fears of distortion of competition.

Lessons

While, it is still too early to learn lessons from KETs projects so far, experiences in the ICT sector as a whole indicate that a more pragmatic approach to commercialisation should be taken (and there are various analyses of this necessity (The Technology Institute, 2012)). In the high-technology areas that KETs cover, making an impact in the market requires strong relationships for with the customer, industrial or consumer:

- Marketing should be taken more seriously in ICT KETs than current documents on the subject show. It must be carefully considered not only by the participant enterprises in the KETs initiative but also by support programmes, particularly as it is a new direction for the policy maker. Large-scale marketing efforts as much as technology are a key feature of the ICT sector, and the KETs programme needs to promote this explicitly.
- The core business model needs to be thought through when entering the market, following on from Pillar 2. Again, this is a new direction for industrial policy makers, who must enable planning and scrutiny at this level in the support programme. For example, ARM's novel business model was the key to its success. However, what business model will gain market success in the future is rarely obvious.

As regards volume sales in the ICT industry, customers may be both competitors and clients at the same time (e.g. as ARM is with Intel, or Intel is with IBM) leading to complex interactions. These relationships often treat IPR as a commercial asset with which to trade, supported by large legal budgets, so that successful global players (e.g. Samsung, Qualcomm and Apple) regard battles over IP as a key marketing weapon, in which IP is the ammunition. Considering IPR policy at a KETs initiative level is a another new direction for the policy maker.

In consequence, it is necessary for policy makers to be aware that budgets must be anticipated for increased global marketing effort and cost each year.

Recommendations

The above lessons indicate that a new emphasis is required for the third pillar in order to achieve commercialisation in a highly competitive global market and extend the KETs remit for global markets:

- A multi-channel marketing strategy – direct sales, indirect sales and building the channels before launching products or/and services – should be developed. No KETs document seen so far touches on marketing, or its channels, presumably seeing this as a task for each project. But in reality, it remains as important as technology and emphasis on it must be considered if exports are to be achieved.
- The establishment of a high quality IPR regime in Europe should be supported. This regime should limit the possibilities of litigation which could stifle innovation. Europe has the opportunity of setting a worldwide benchmark for patents through the superiority of the European patent system. This is more supportive of real innovation than the USA's form of IPR protection, which has produced ammunition for litigation. However it may be wise to accumulate IPR to use as a strategic asset, most specifically in the USA and when competition with players from the USA is contemplated. While a US approach to patents might seem attractive initially, a fuller analysis (Bessen, 2012; Shapiro, 2001) shows that the more rigorous European IPR regime may favour emerging technology players against dominant players and non-performing entities. The EU position of not recognising patents for software or business models may also be an advantage.
- Policy should also emphasise the need to build awareness of new products and services, and to use marketing campaigns for all the relevant market segments – businesses, consumers -, and position products according to the target audience.

- The business model (and business plan) for Pillar 3 marketing should be as innovative as the R&D and the Pillar 2 prototype productization of that R&D.
- The product should be constantly updated, with a specific roadmap for engineering, so that key competitors cannot catch up.

3. How can KETs policy contribute to regional development?

The European Commission has identified KETs as an investment priority for regional innovation financing and has reinforced policy support for KETs in its proposal for the future European Regional Development Fund (ERDF). In particular, it will maintain "technological and applied research, pilot lines, early product validation actions, advanced manufacturing capabilities and first production in KETs and diffusion of general purpose technologies". Note that regional development implies the possible use of multiple funding sources that may be combined to provide the long-term finance for new ventures.

3.1 How ICT KETs can contribute to regional development with several lines of support

Hi-tech clusters around technologies such as KETs could be an appropriate mechanism for translating knowledge-based advances into employment for the long term. Smart specialisation at a regional level, may be used. This requires that the KET be aligned with a region's capabilities and characteristics to transfer skills that can be embedded locally. It requires an initial assessment of the structural conditions necessary for innovation in a specific KET. There are many examples of successful clusters which may act as templates when looking at new target regions, using smart specialisation to identify the unique resources and knowledge areas required, as well as market areas to be aimed at:

- Europe has a growing number of clusters for the ICT KETs (IPTS, 2012). The Irish cluster for nanotechnology set up over the past decade is one example (Forfas, 2010). Another is Germany's Dresden with its focus on micro- and nano-electronics with the advanced materials and advanced manufacturing systems needed for their fabrication (City of Dresden, 2013). Dresden provides an example of a cross-KET cluster, which attracts outside investors (AMD, Intel, Applied Materials) and their FDI, in a similar fashion to Cambridge in the UK for a comparable range of semiconductors and flexible micro-circuits, displays, M2M chips (ARM, CSR, CDT, Nuel) and Grenoble in France (with ARM, CEA, HP).
- Robotdalen, a robotics cluster in Sweden, is a non-KETs European cluster which is nonetheless interesting for its financing model. It has been built on long-term financing from the government venture investor, Vinnova, and is similar to the three-pillar KETs model. Robotdalen confirms the potential of the KETs development model in establishing a future regional development (Vinnova, 2010).
- The most extreme example of enabling technologies for ICTs triggering regional growth is Silicon Valley. It should be noted that its evolution has stretched over 75 years since its beginnings in the late 1930s with the likes of the Varian brothers and Hewlett Packard, around Stanford University.

In summary, a KETs cluster can bring basic manufacturing and R&D facilities as the core for development. Secondly, it encourages a local supply chain, an ecosystem to support production and R&D and also a distribution chain and pre-normative research and associated fields with their skills. These often have a geographic focus such as science parks.

Thus clusters around KETs could be promoted as a means of fostering regional development. A key example here is the Irish nanotechnology cluster (Forfas, 2010).

Going further than just clusters for regional development, an ICT KET may also introduce a string of related businesses and a 'soft infrastructure' with economic benefits:

- A new skills base for the region – requiring the formation of education and training establishments for:
    - Industrial apprenticeships – important for regional youth employment problems, for example
    - Centres of engineering and design excellence, which may act as the foci for establishing an eco-system around an ICT KET bringing expanded tertiary education and its skilled resources
- Secondary effects on the regional economy, as new sources of wealth enter, demanding business and other support services. These may range from building infrastructure for telecommunications, power and transport to everyday retail and domestic services and also construction for plant and residential centres. This may promote plus the restoration or creation of local amenities in the neighbouring communities. One example here is Sophia Antipolis in France, where the high technology base has created a whole local economy beyond tourism and agriculture.
- Expansion in available investment finance – with the potential for FDI as outside technology specialists come to the region, and for the establishment of a local VC community.

3.2 Which of the five ICT KETs is likely to be most important to regional development?

Some KETs may be more valuable to regional development than others, but each KET has characteristics that may suit, or else not align with the economic and demographic variables of a particular region. Possibly the most significant ICT KET for leveraging many regional developments is Advanced Manufacturing Systems. Manufacturing is a critical foundation for all the emerging technologies, such as KETs, as they all depend on AMS to varying extents – perhaps completely for electronics and photonics – and for many advanced materials also.

4. Socioeconomic impacts

ICT KETs initiatives will have various kinds of socioeconomic impact, the most significant of which is likely to be economic. However, various social issues will also arise as a result of the establishment of high technology centres, new skills and cultures. A third effect will be the influence that ICT KETs have on the market, i.e. when new products based on or including ICT KETs are introduced into the energy, transport, leisure, and health fields, etc.

Looking at the primary effects of economic stimulation, it is anticipated that KETs will bring an increase in long term-employment, while raising the skills level of the workforce in Europe, with a trend to jobs with higher added value. The differentiator for KETs, as opposed to other technologies, is that they are chosen as being key to economic and industrial regeneration, with a long life-cycle. The socioeconomic benefits could therefore be generally increased if KETs succeed in:

- *Acting as an employment multiplier*: The economic leverage created by one particular KET – advanced manufacturing systems – may have the highest impact, since it could rejuvenate Europe's core manufacturing base. AMS is especially important to EU employment: about 1 in 10 of all enterprises in the EU27's non-financial business economy were classified as being in manufacturing in 2010 for a total of 2.1 million enterprises. Thus, if AMS succeeds, up to 10%

of the European industrial base could benefit. Moreover, AMS should stimulate the key sub-sector for employment, that of micro-firms and SMEs.

- *Stimulating exports*: KETs, if correctly structured and scoped, might be a significant factor in the recovery of Europe's manufacturing base for exports.
- *Creating centres of excellence*: seeding clusters in regional economies could be significant for 'levelling the playing field' in terms of economic development outside the large EU economies, especially for the least developed Member States, and others, needing industrial rejuvenation.
- *Acting as an educational stimulus*: with demand for skills, especially in engineering, to build long-term intellectual capital in the EU workforce and more high-technology centres of learning.

Secondly, KETs may reorganise society, since they may increase the numbers in skilled employment. They may also tend to affect the structure of society by driving upwards mobility for technically skilled workers. Tertiary education could then drive mobility further, as skilled workers gain the higher level qualifications. The overall effect would be a higher value workforce, with an improvement in Europe's human capital. That might have a secondary cultural effect on social structures and on the balance between skilled and unskilled workers in the population, with beneficial social and economic levels of achievement. Here, KETs could help with the major problems of youth unemployment in the EU, by driving high-tech apprenticeships, if the skills demanded can be met by early training in KETs' technology vocations. However, this does require the Member States to invest in both the KETs areas and the necessary education and training. Germany is certainly aware of this and provides the most interesting example.

Finally, ICT KETs-based innovations may give rise to products in fields that impact society, such as health. Perhaps more importantly it is the affordability of advanced products such as those for social communications (e.g. social networking) as well as their very nature – more visual than voice or text - that will expand their use. Two of the most important areas will be improving healthcare and supporting the aged. Expanding the scope of the KETs programme (e.g. with software, robotics, novel radio technologies, etc.) could provide a substantial stimulus for telemedicine and telecare and general health standards beyond 2020. On the downside, some products – such as those from the nanotechnology discipline - will require more awareness of their potential negative effects.

5. Recommendations for further actions to promote success with ICT KETs

Because of the importance of KETs for Europe in terms of growth and jobs, an important question is what further actions could promote success with (ICT) KETs, beyond the already on-going EU KETs initiatives? A more forward-looking strategic development of the KETs initiative would include consideration of socioeconomic aspects of future KETs policy. It would also include a long-term view of global competition and trends in global ICT markets, up to 2040 or 2050, to justify a capital-intensive EU industrial policy. This long-term view would complement current activities of the EU KETs Observatory, which provides quantitative and qualitative information on the performance of EU Member States and competing economies regarding the deployment of KETs. A further part of this strategy would be to review and complement the selection of ICT-based KETs against their impacts on the future global economy, especially in view of the large sums envisaged.

Several actions would therefore be necessary to pursue this longer-term strategic approach, which include:

- In-depth analysis of the socioeconomic impacts of KETs in the short, medium and long term. It could include considerations of the ethical dimension in KETs developments and promotion, such as confidentiality and privacy protection, as well as security and environmental aspects. This could also cover the potential “dark-side” scenarios of KETs.

- Creating a greater understanding of the future *demand side* of ICT-based KETs required to identify the key opportunity areas in ICT KETS.
- Exploring other areas where additional ICT–based KETs need to be pursued but are not. An analytic programme for new KETs research topics in ICT-based KETs may be needed, possibly including a review of current ICT KETs.
- Consideration of whether the current support measures are focused appropriately for the long term (2040 to 2050) – a key question for setting future policy. This would require comparative analysis of the EU’s approaches in KETs funding with the extent and mechanisms outside the EU, specifically in the key Asian economies, as well as the USA.

In consequence, there are several concrete examples of activities to consider, which could increase the impacts of the KETS programme. These are placed in priority order:

1. Provide an in-depth, long-term impact analysis of the ICT KETs on society, and on the economy, projecting the future technological base to be expected in Europe, in its revised expanded form. It should also cover where KETs would present second order effects, on sustainability, employment, skills base, regional development, social cohesion, support for ageing, and so on.
2. Promote interdisciplinary ICT KETs support with wider scope, to include other ICT KETs that cover areas of future market demand. This would follow an initial review of the current selection of ICT KETs to suggest suitable KETs additions, in view of market demands, SME opportunities, regional developments, etc. It would require full market analysis and an exploration of the implications for support for final commercialisation.
3. Further in-depth analysis of each chosen contender for potential inclusion could then be evaluated. This would require full market analysis and also examine horizontal effects of the KET on the whole socioeconomic environment, but specifically for SMEs, and the support for commercialisation that they would require.
4. Introduce the ICT innovation dimension of design. This may require an initial analytic study first on the role of design in current ICT innovation, and second, on how to apply industrial design coherently across the KETs programme.
5. Prepare and promote a shift towards marketing analysis required for deeper demand understanding. This should look at the trends in the short, medium and long term, including global demand.
6. Perform a comparative overseas analysis of KETs equivalents in the long term up to 2050 and how KETs fit in with innovation policy in China, Korea, the USA, Japan, Taiwan and Singapore.
7. One outstanding issue is that the negative impacts of ICT KETs have not really been addressed in the KETs literature so far. This gap could well be a study area.
8. There is a lack of knowledge of the impacts of ICT KETs on product innovation and other effects. This is a new field for specific research, to assess and forecast the innovation impacts of ICT KETs at all levels of markets, products and socioeconomic effects.
9. Examine potential new investment models for KETs, including a European Sovereign Wealth Fund for technologies, FDI encouragement, and so on, including crowdfunding for SME ventures.
10. To aid the above funding analysis, the KETs programme governance models could be reviewed to understand whether funds are bringing successful returns long term.

Bibliography

Bessen, James (2012), *Patent Failure in the Digital World*, presentation, Paris June 2012.

Cisco (2014), *Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2013–2018*, http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.pdf

City of Dresden (2013), *Dresden, Europe's Largest Cluster for Flexible Electronics*, www.dresden.de/media/pdf/wirtschaft_extern/dresden-flexible-electronics-2013.pdf

de Helde, M., et al (2013), *Vision and characteristics of Multi-KETs Pilot Lines*, http://www.mkpl.eu/uploads/media/mKPL-_Green_Paper_v5.03.pdf

European Commission (2009), *Preparing for our future: Developing a common strategy for key enabling technologies in the EU*, Brussels, COM(2009) 512 fin, 30 September, http://ec.europa.eu/enterprise/sectors/ict/files/communication_key_enabling_technologies_sec1257_en.pdf

European Commission (2012), A *European strategy for Key Enabling Technologies – A bridge to growth and jobs*, Brussels, COM(2012) 341 final, 26 June, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52012DC0341:EN:NOT

European Commission (2014), "5G Infrastructure PPP: The next generation of communication networks will be 'Made in EU'", Digital Agenda for Europe, http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=4445

Eurostat, accessed 12 March 2014 for latest figures for EU (2010).

Forfas (2010) *Ireland's Nanotechnology Commercialisation Framework, 2010-2014*, LUX Research, August, http://www.forfas.ie/forfas310810-nanotech_commercialisation_framework_2010-2014.pdf

High Level Expert Group on Key Enabling Technologies (2011), Final Report, European Commission, Brussels, http://ec.europa.eu/enterprise/sectors/ict/files/kets/hlg_report_final_en.pdf

IPTS (2010) *A Helping Hand for Europe: The Competitive Outlook for the EU Robotics Industry*, EUR 24600 EN – 2010, http://is.jrc.ec.europa.eu/pages/ISG/COMPLETE/robotics/

IPTS Programme (2010-2013) European ICT Poles of Excellence (EIPE): http://is.jrc.ec.europa.eu/pages/ISG/EIPE.html

ISTAG (2012) *Software Technologies, the Missing Key Enabling Technology; Towards a Strategic Approach to Software Technologies in Europe*, July, http://cordis.europa.eu/fp7/ict/docs/istag-soft-tech-wgreport2012.pdf

Merritt, Rick (2013), "5G Dials up global effort", *EE Times*, 24 December, www.eetimes.com/document.asp?doc_id=1320491

Shapiro, Carl (2001), "Navigating the patent thicket, cross-licences, patent pools and standard setting", in Adam B. Jaffe et al, eds (2001), *Innovation Policy and the Economy*, MIT Press.

The Technology Institute (2012), *Technology Industry at the Crossroads: Transforming Quote to Cash Operations*, http://www.pwc.com.br/pt_BR/publicacoes/setores-atividade/assets/produtosconsumo-varejo/pwc-technology-industry-at-the-crossroads-transforming-quote-to-cash-operations.pdf

Vinnova (2010), *From Low Hanging Fruit to Strategic Growth – International Evaluation of Robotdalen*, Report VR2010-16, July, www.vinnova.se/upload/EPiStorePDF/vr-10-16.pdf

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